Japanese Dental Science Review (2018) xxx, xxx—xxx

Contents lists available at ScienceDirect

Japanese Dental Science Review

journal homepage: www.elsevier.com/locate/jdsr

Review Article

Effects of blue-light irradiation during dental treatment☆

Fumihiko Yoshino*, **Ayaka Yoshida**

Division of Photomedical Dentistry, Department of Oral Science, Graduate School of Dentistry, Kanagawa Dental University, Japan

Received 23 February 2018; received in revised form 1 June 2018; accepted 27 June 2018

KEYWORDS
Blue light;
Heat damage;
Reactive oxygen species and free radicals;
Oxidative stress;
Antioxidant

Summary In dentistry, blue light is widely used for tooth bleaching and restoration procedures involving composite resin. In addition, many dentists use magnification loupes to enable them to provide more accurate dental treatment. Therefore, the use of light is indispensable in dental treatment. However, light can cause various toxicities, and thermal injuries caused by light irradiation are regarded as particularly important. In recent years, the eye damage and non-thermal injuries caused by blue light, the so-called ''blue light hazard'', have gained attention. Unfortunately, much of the research in this field has just begun, but our recent findings demonstrated that blue-light irradiation generates reactive oxygen species (ROS) and induces oxidative stress in oral tissue. However, they also showed that such oxidative stress is inhibited by antioxidants. There have not been any reports that suggested that the ROS-induced phototoxicity associated with blue-light irradiation causes direct clinical damage, but some disorders are caused by the accumulation of ROS. Therefore, it is presumed that it is necessary to suppress the accumulation of oxidative stressors in oral tissues during treatment. In the future, we have to promote discussion about the suppression of phototoxicity in dentistry, including concerning the use of antioxidants to protect against phototoxic damage.

☆ Scientific field of dental science: Photochemistry and Photobiology.

* Corresponding author at: Division of Photomedical Dentistry, Department of Oral Science, Graduate School of Dentistry, Kanagawa Dental University, 82 Inaoka-cho, Yokosuka, Kanagawa 238-8580, Japan.
E-mail address: yoshino@kdu.ac.jp (F. Yoshino).

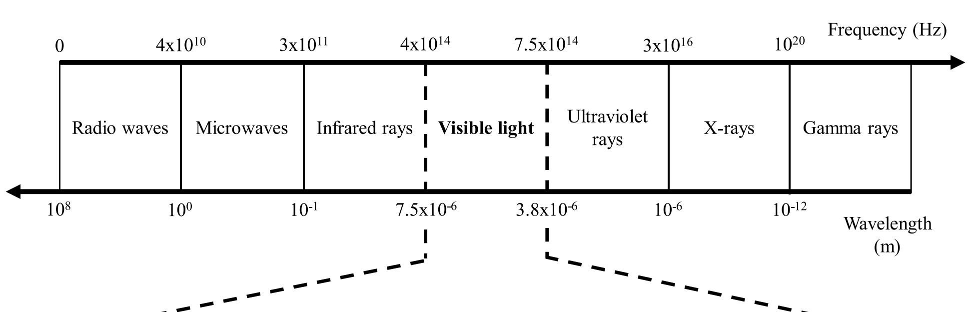
https://doi.org/10.1016/j.jdsr.2018.06.002

Contents

1. Introduction

Recently, the esthetics of the smile and teeth, including tooth color, have become of great importance to patients, resulting in an increase in the frequency of requests for tooth bleaching. In-office vital tooth bleaching is one of the most popular bleaching methods and is based on the application of 25—40% hydrogen peroxide products to the external surfaces of the teeth. Moreover, various blue light-producing units for vital tooth bleaching, such as halogen curing lights, light-emitting diodes (LED), diode lasers, argon lasers, and plasma arc lamps, have been introduced in order to achieve better activation of hydrogen peroxide within a shorter time period, resulting in better esthetic outcomes. The bleaching mechanism underlying such treatment is considered to involve the penetration of hydrogen peroxide into teeth and the production of free radicals, which can oxidize organic stains [1,2]. In addition, since the 1980s blue light, which has similar biocidal effects to ultraviolet (UV) radiation, has been frequently applied to photo-activated resin composite systems to provide protection during tooth restoration procedures [3—5]. Furthermore, high-power LED irradiation has been used to shorten the treatment time relative to that of conventional dental therapy [6]. Therefore, blue light is indispensable for modern dental treatment.

While there has been lots of research into the damage to the eyes and skin caused by UV rays, there are few reports about the effects of blue light on the human body, particularly on oral tissue [7,8]. We have investigated the effects of blue light on biological tissues and cells. The reactions induced by blue light mainly involve reactive oxygen species (ROS), which are generated by pigment excitation and cause oxidative stress [9,10]. It has also been reported that the thermal reactions induced by light irradiation cause biological damage [11,12]. Since these effects are undesirable in biological systems, protective measures against them are required. This review summarizes the current understanding of the mechanisms underlying the effects of blue light on oral tissues and discusses possible protective measures against these phenomena.



Visible spectrum	Wavelength (nm)	Energy (eV)
Violet	380–450	2.755–3.260
Blue	450–495	2.500–2.755
Green	495–570	2.175–2.500
Yellow	570–590	2.100–2.175
Orange	590–620	1.990–2.100
Red	620–750	1.650–1.990

Figure 1 The light spectrum is composed of electromagnetic waves of many different wavelengths.
Images are produced via the manipulation and presentation of different visible wavelengths of the electromagnetic spectrum. Visible light is the part of the spectrum with wavelengths ranging from 380 nm to 780 nm.
This figure was adapted from the diagram of Freedman et al. [14].

Please cite this article in press as: Yoshino F, Yoshida A. Effects of blue-light irradiation during dental treatment. Japanese Dental Science Review (2018), https://doi.org/10.1016/j.jdsr.2018.06.002